97

(12) UK Patent Application (19) GB (11) 2 221 513 (13) A

(43) Date of A publication 07.02.1990

(21) Application No 8818680.4

(22) Date of filing 05.08.1988

(71) Applicant
Ford Motor Company Limited

(Incorporated in the United Kingdom)

Eagle Way, Brentwood, Essex, United Kingdom

(72) Inventor
Eric John Banks

(74) Agent and/or Address for Service
A Messulam & Co
24 Broadway, Leigh-on-Sea, Essex, SS9 1BN,
United Kingdom

(51) INT CL⁴
F16D 3/10, F01L 1/34

(52) UK CL (Edition J)
F2U U318
U1S S1990

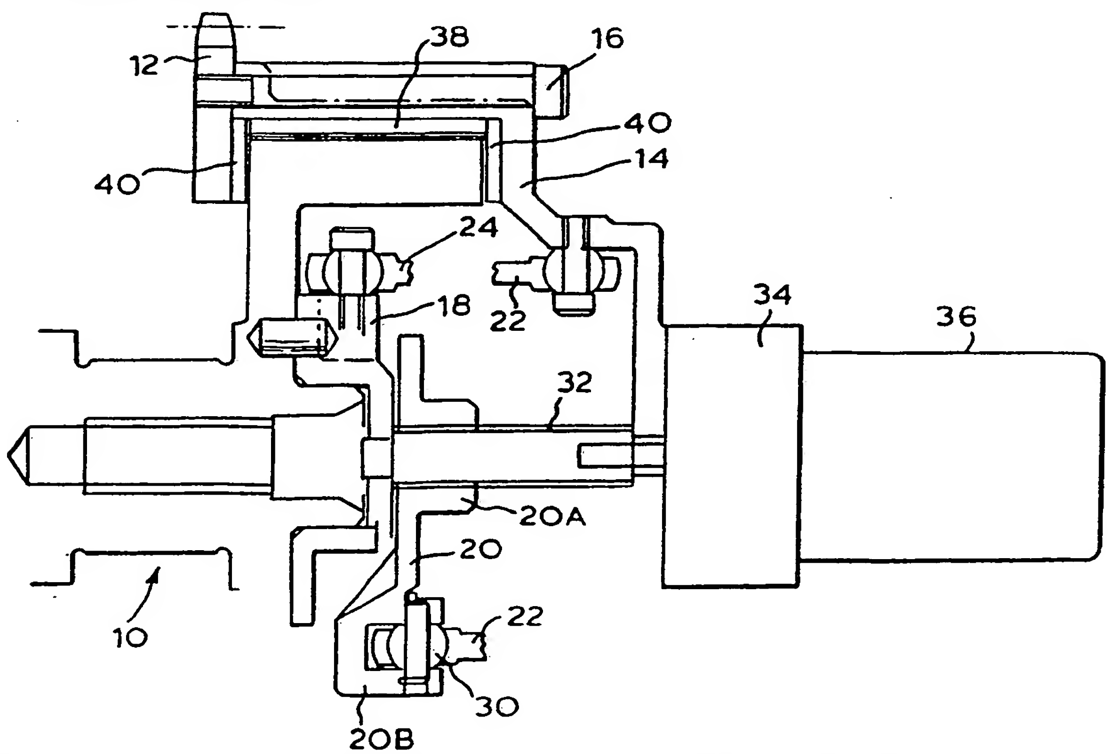
(56) Documents cited
None

(58) Field of search
UK CL (Edition J) F1B, F2K, F2U
INT CL⁴ F01L 1/34, F16D 3/10

(54) Variable phase drive mechanism

(57) In a mechanism for varying the phase of concentrically mounted drive and driven members, such as a drive sprocket and a camshaft of an internal combustion engine, the two members 10, 14 are prevented from moving axially relative to one another and an axially displaceable spider 20, mounted between the drive 14 and driven 10 members, is connected for rotation with both the drive member 14 and the driven member 10 to transmit torque from the drive member 14 to the driven member 10.

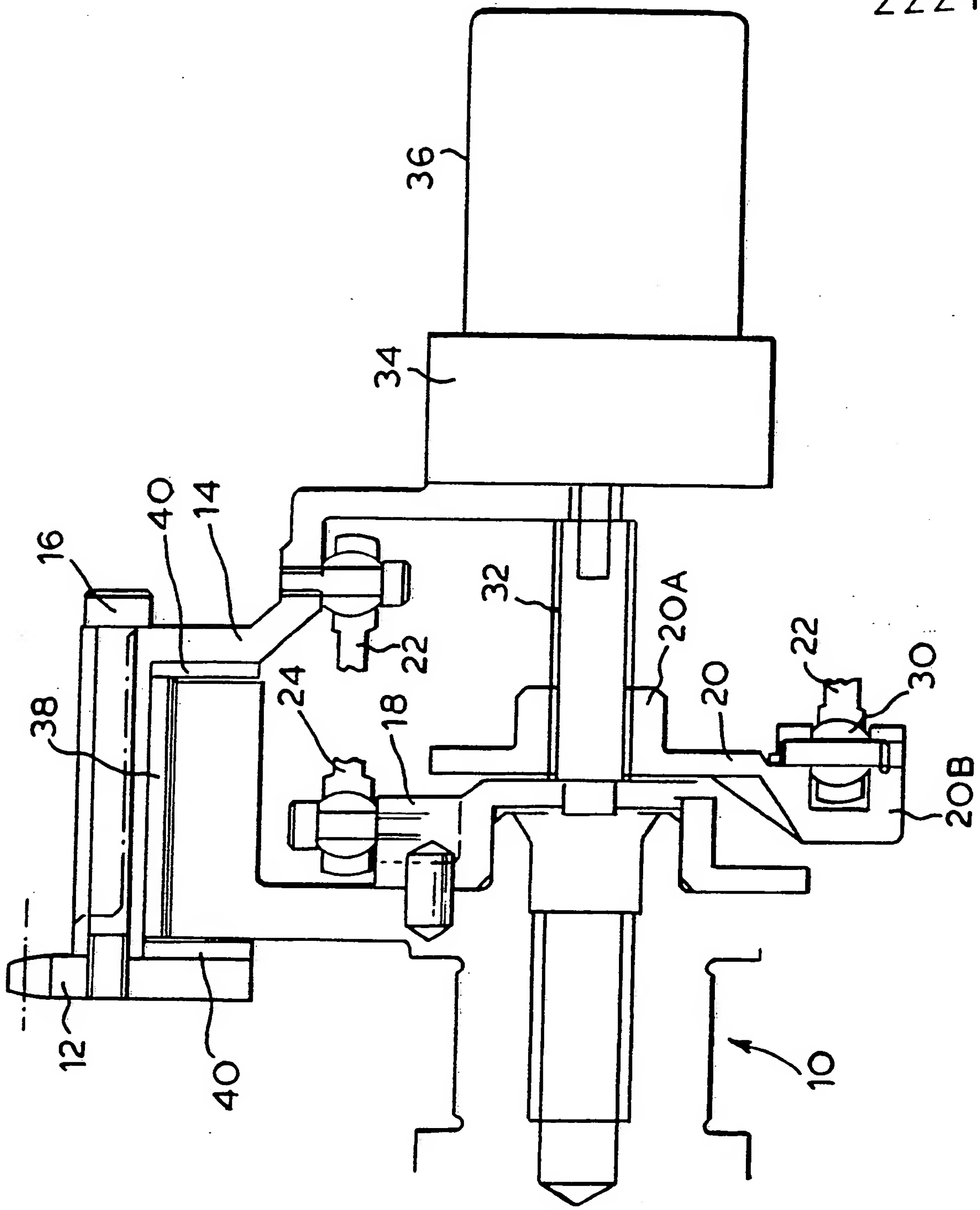
The coupling between the spider 20 and at least one of the other members 10, 14 is effected by two or more pivotable link arms 22, 24, the coupling being such that axial movement of the spider 20 results in relative angular displacement between the drive and driven members.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 221 513 A

2221513



2221513

VARIABLE PHASE DRIVE MECHANISM

The invention relates to a mechanism for varying the phase of a driven member relative to a drive member. The invention can be used for the camshaft of an internal combustion engine and in particular to varying the relative phase of opening and closing of the inlet and exhaust valves in a dual overhead camshaft internal combustion engine.

The optimum times for opening and closing the inlet and exhaust valves in an internal combustion engine vary, inter alia, with engine speed. In any engine with fixed angles for opening and closing the valves for all engine operating conditions, the valve timing is a compromise which detracts from the engine efficiency in all but a limited range of operating conditions. It has been proposed previously for this reason to vary the valve timing during engine operation.

In other systems, variation of the valve timing has been proposed as a means for regulating the engine output power. For example, if the inlet valve is allowed to remain open for part of the compression stroke, the volumetric efficiency of the engine can be reduced. Such a system requires an even greater range of control over the phase of the camshaft and the control needs to be continuous over the full adjustment range.

Various proposals have been made for adjustment of the camshaft phase angle relative to the crankshaft but these systems have all been complex on account of the need to withstand the considerable torque fluctuations experienced by a camshaft during normal operation. The system must also supply the force required to rotate the camshaft against the resistance offered by the valve springs which need to be compressed.

For example, it has been suggested to include a helical gear on the camshaft and to provide some form of mechanism, be it hydraulic or electro-mechanical, for axially moving the helical gear to cause the phase of the camshaft to change.

The prior art systems have therefore all involved considerable expense and many have created packaging problems on account of their size. Generally, these mechanism have only permitted a limited degree of phase adjustment, typically 15° at the camshaft, which is not sufficient for regulation of the engine output power.

Bearing in mind the cost of the phase changing mechanism and the additional load which it creates to derive the necessary power for rotating the camshaft, it has not hitherto proved generally commercially viable.

With a view to mitigating at least some of the foregoing disadvantages, the present invention provides a mechanism for varying the phase of concentrically mounted drive and driven members, wherein the members are prevented from moving axially relative relative to one another, and wherein an axially displaceable member is mounted axially between the drive and driven members and is connected for rotation with both the drive member and the driven member to transmit torque from the drive member to the driven member, the coupling between the axially displaceable member and at least one of the other members being effected by two or more pivotable link arms, the coupling being such that axial movement of the axially displaceable member results in relative angular displacement between the drive and driven members.

By virtue of the fact that the axially displaceable member is connected to the drive and/or the driven member by means of pivotable link arms, as opposed to

gears or other coupling elements, it is possible to eliminate all backlash in the couplings.

The link arms pivot as the axial displaceable member moves axially and this calls for the link arms to pivot in two planes. The ends of the link arms need therefore to be ball joints.

Advantageously, the ball joints may be self-lubricating ball joints, for example using a PTFE race. Such ball joints are known which can readily withstand the loading in the application of the invention to a camshaft phase change mechanism without any backlash.

It is preferred that the axially displaceable member should be connected by pivotable link arms to both the drive and the driven members. The effect of this is that the axially displaceable member will now rotate relative to both the driven member and the drive member as it is moved axially and a consequence of this is that while the mechanical advantage of one set of link arms is decreasing, the other is increasing thereby tending to reduce variations in the force required to effect the phase change throughout the range of operation. or driven member.

In order to effect the axial movement of the axially displaceable member, a motor may be mounted for rotation with the drive and driven members and connected in a suitable manner to the axially displaceable member. For example, the axially displaceable member may be internally threaded and mounted on an externally threaded shaft rotatable by the motor.

The motor may conveniently be an electric motor to which current is supplied through slip rings. Alternatively, a hydraulic or other motor may be employed.

The invention will now be described further, by way of example, with reference to the accompanying drawing which is schematic axial section through a variable phase drive mechanism of the invention.

A camshaft 10 constituting the driven member in the described embodiment is driven by a sprocket 12. A casing 14 is secured to the sprocket 12 by means of bolts 16 and serves to contain the components of the variable phase drive mechanism.

A hub 18 is mounted on the camshaft 10 by means of bolts which are not shown in the drawing. A spider 20 which constitutes the axially displaceable member is mounted between the casing 14 and the hub 18. The spider has a central section 20A which is internally threaded and three generally radial arms 20B each of which carries two ball or knuckle joints. A first set of link arms 22 connects the radial arms of the spider 20 to the casing 14 and a second set of link arms 24 connects the radial arms of the spider 20 to the hub 18. Each link arm 22, 24 terminates at a ball joint 30 and in is capable of pivoting in two planes.

The central section 20A of the spider 20 is mounted on a threaded output shaft 32 of a gearbox 34 driven by an electric motor 36, the gearbox being mounted on the casing 14. Power is supplied to the electric motor 36 through slip rings, not shown.

The sprocket 12 and the casing 14 are fitted over the end of the camshaft 10. A journal bush 38 supports the casing 14 on the camshaft 10 and axial thrust washers 40 are arranged on both sides of the journal bush 38. As a result, the casing is fixed axially relative to the camshaft 10 and can only rotate relative to the camshaft.

In any single axial position of the spider 20, the the sprocket 12, casing 14, the camshaft 10, the link arms 22, 24 and the motor and gearbox 34, 36 all rotate as a single unit. If current is passed through the motor 36, then it drives the shaft 32 through the gearbox 34 and on account of the threaded engagement between the shaft 32 and the central portion of the spider 20, the latter is forced to move axially. As it moves axially, the spider 20 causes the link arms 22 and 24 to pivot and this has the effect of angularly displacing the spider relative to the camshaft and the casing 14 and of angularly displacing the casing 14 relative to the camshaft 10. The use of ball jointed link arms for the coupling ensures that there is no play in the coupling and the axial position of the spider 20 accurately sets the desired phase of the drive mechanism.

CLAIMS

1. A mechanism for varying the phase of concentrically mounted drive and driven members, wherein the members are prevented from moving axially relative relative to one another, and wherein an axially displaceable member is mounted axially between the drive and driven members and is connected for rotation with both the drive member and the driven member to transmit torque from the drive member to the driven member, the coupling between the axially displaceable member and at least one of the other members being effected by two or more pivotable link arms, the coupling being such that axial movement of the axially displaceable member results in relative angular displacement between the drive and driven members.

2. A mechanism as claimed in claim 1, wherein the axially displaceable member is connected by pivotable link arms to both the drive and the driven members.

3. A mechanism as claimed in claim 1 or 2, wherein three link arms are provided in each coupling between the axially displaceable member and the respective drive or driven member.

4. A mechanism as claimed in any preceding claim, wherein a motor is mounted for rotation with the drive and driven members and is connected to the axially displaceable member.

5. A mechanism as claimed in claim 4, wherein the motor is an electric motor, current being supplied to the motor through slip rings.

6. A mechanism as claimed in claim 4 or 5, wherein the axially displaceable member is internally threaded and is mounted on an externally threaded shaft rotatable by the motor.

7. A mechanism as claimed in any preceding claim, wherein the driven member is the camshaft of an internal combustion engine and the drive member is a sprocket, gear or toothed belt pulley driven in synchronism with the engine crankshaft.

8. A mechanism constructed, arranged and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

Published 1990 at The Patent Office. State House. 66 71 High Holborn. London WC1R 4TP. Further copies may be obtained from The Patent Office. Branch. St Mary Cray. Orpington. Kent BR5 3RD Printed by Multiplex techniques ltd. St Mary Cray. Kent. Con. 1/87